

## A NEW SPECIES OF *EUPSOPHUS* (AMPHIBIA: ANURA: LEPTODACTYLIDAE) FROM SOUTHERN CHILE

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*Abstract.*—*Eupsophus emiliopugini*, a new species of leptodactylid frog, is described from southern Chile. This species is distinguished from its congeners by the olive-green cephalic pigmentation. The mating call is composed of two notes and the tadpole is typically an inhabitant of ground water-filled cavities. This frog occurs from eastern Osorno Province through Llanquihue, Chiloé, and Aisén provinces.

The genus *Eupsophus* Fitzinger, 1843 is restricted to the temperate *Nothofagus* forest of the southwestern border of South America. At present five species have been described (*E. roseus*, *E. vittatus*, *E. calcaratus*, *E. Migueli*, and *E. insularis*) (Formas & Vera 1982, Formas 1985), and for this reason *Eupsophus* can be considered the most diverse genus within the reduced anuran fauna of the temperate forest system of southern Chile and Argentina. Among the genera of the sub-family Telmatobiinae, *Eupsophus* is remarkable by having tadpoles (*E. roseus*, *E. vittatus*, and *E. calcaratus*) which live in small water-filled cavities in the ground. The larval mouthparts (denticles) are reduced, and the larvae feed only upon yolk reserves (Formas & Pugín 1978a, b; Formas 1989).

Between September 1975 and December 1987, Carlos Varela, Lila Brieva, Gonzalo Aguilar and I collected specimens of a new species of *Eupsophus* in the temperate *Nothofagus* forest of southern Chile. In this paper the new taxon is described on the basis of a series of materials (adults, juveniles, mating call, eggs, and tadpoles) collected from seventeen localities.

*Eupsophus emiliopugini*, new species  
Fig. 1

*Holotype.*—IZUA (Instituto de Zoología, Universidad Austral de Chile) 1587, adult

male; Ramón Formas, Nov 28, 1975, at La Picada, 23 km NE (by road) of Ensenada (Fig. 2), Osorno Province, Andean Range, 41°04'S, 72°26'W, 480 m.

*Paratypes.*—Seven adult males from the type locality: IZUA 1585–86, 1593, 1596, 1602, 1607–8.

*Diagnosis.*—*Eupsophus emiliopugini* is a medium-sized frog which is characterized by having a distinctive olive-green band between the eyes, which is absent in *E. roseus*, *E. calcaratus*, *E. vittatus*, *E. Migueli* and *E. insularis*. Furthermore it differs from *E. vittatus* in snout–vent length (Table 1). The mating call of *E. emiliopugini* has two notes while that of *E. vittatus* possesses five (4–6) notes (Table 2).

*Adult description.*—(Based on 25 living frogs and 29 fixed specimens.) Head wider than long. Snout pointed in dorsal view, slightly sloping in lateral profile; canthus rostralis indistinct and rounded; loreal region slightly concave; nostrils dorso-lateral, closer to tip of snout than to the orbit; length of the eye greater than distance between eye and nostril; inter-orbital distance narrower than length of eye, greater than internarial distance. Tympanic membranae medium and well defined, tympanum diameter three fourths the distance between eye and nostril. Well developed supratympanic fold extending posteriorly from the corner of the eye to the posterior part of the tympanum, cov-



Fig. 1. *Eupsophus emiliopugini*, new species. Holotype (IZUA 1587).

ering upper part of tympanic annulus but not reaching insertion of arm. Tongue large, ovoid, with notch at the tip. Choanae small, round dentigerous process of vomers lying slightly below choanae; each process bearing 3–4 slightly oblique teeth close to median line. Forelimbs thin. First finger equal in length to second; third finger much longer than fourth; digital length in decreasing order 3-4-2-1. Palmar webbing absent; tips of fingers rounded and slightly prominent. Inner median palmar tubercle ovoid; outer palmar tubercle horseshoe-shaped; subarticular tubercles globular and moderate in size; supernumerary palmar tubercles present. Hind limbs slender. Toes long, slender, and moderately fringed; tips of toes rounded; third and fifth toes equal in length; toes in decreasing order of length 4-(3,5)-2-1. Inner metatarsal tubercle ovoid and prominent, outer rudimentary. Subarticular tubercles ovoid; supernumerary tubercles absent. Tarsal fold absent. Rudiment of web among toes. Anal opening oriented transversely and directed postero-ventrally at dorsal level of thighs. Dorsal and ventral skin smooth. Two weakly developed para-

vertebral folds extending from posterior part of head, converging behind it. Post-tympanic areas and flanks with scarce minute granules. Some specimens with slight granular area around vent and posterior part of thighs. External measurements of males and females of this species shown in Table 1.

*Coloration in preservative.*—Dorsal ground color light gray with few whitish minute spots; a delicate vertebral line extending from the tip of snout to the vent. A dark greenish band on the eyes. Venter whitish and gular area gray. Lips gray with two or three irregular spots reaching the tympanic region. Arms light gray and crossed by two or three irregular transverse bars of dark gray color in dorsal area; arms and legs whitish ventrally.

*Coloration in life.*—Dorsal ground color grayish brown to leaden; vertebral line lemon-yellow. Band on eyes olive-green colored. Some specimens with bright yellowish reticulations on the thighs. Belly whitish and the gular area of mature males bright orange.

*Distribution.*—The presently known range of *E. emiliopugini* extends from northeast-

Table 1.—Comparative measurements (mm) of *Eupsophus emiliopugini* and *E. vittatus*. Means, SD, and ranges (parenthesis).

Character	<i>E. emiliopugini</i>		<i>E. vittatus</i>	
	Females	Males	Females	Males
n	14	40	19	19
Snout-vent length	50.61 ± 5.01 (41.0–64.0)	46.71 ± 24.00 (42.9–50.0)	59.61 ± 6.38 (47.0–71.8)	55.44 ± 8.68 (44.5–66.6)
Head length	17.93 ± 1.82 (13.4–20.8)	16.45 ± 0.69 (14.8–18.1)	20.43 ± 1.50 (16.7–23.9)	18.36 ± 2.30 (15.4–21.3)
Head width	19.83 ± 2.19 (15.9–25.6)	18.48 ± 0.33 (16.9–19.1)	23.66 ± 2.02 (19.9–26.6)	21.72 ± 3.38 (18.1–26.0)
Femur length	23.38 ± 2.47 (17.1–29.2)	21.96 ± 1.06 (16.6–24.3)	28.45 ± 1.89 (24.7–31.2)	26.37 ± 3.83 (21.7–31.6)
Tibia length	24.2 ± 2.0 (19.9–29.6)	24.25 ± 4.43 (19.30–33.1)	28.98 ± 2.05 (25.0–32.2)	27.2 ± 4.18 (22.8–33.1)
Foot length	35.9 ± 3.56 (29.1–44.9)	36.52 ± 7.10 (29.7–49.1)	41.83 ± 3.56 (34.4–48.2)	41.26 ± 5.37 (33.8–49.1)

ern Osorno Province (Termas de Puyehue) to Aisén Province (Caleta Vidal) (Fig. 2). This area is covered by humid and cool *Nothofagus* forests, which are found at the Andes Cordillera (below 1000 m), the Coastal Range, the Central Valley, and on Chiloé Island. The altitudinal distribution of *E. emiliopugini* ranges between the sea level (Caleta Vidal) and 700 m in the Andes Cordillera (Termas de Puyehue). Over much of its range, *E. emiliopugini* occurs sympatrically with *E. calcaratus*. It has never been found in sympatry with *E. vittatus*.

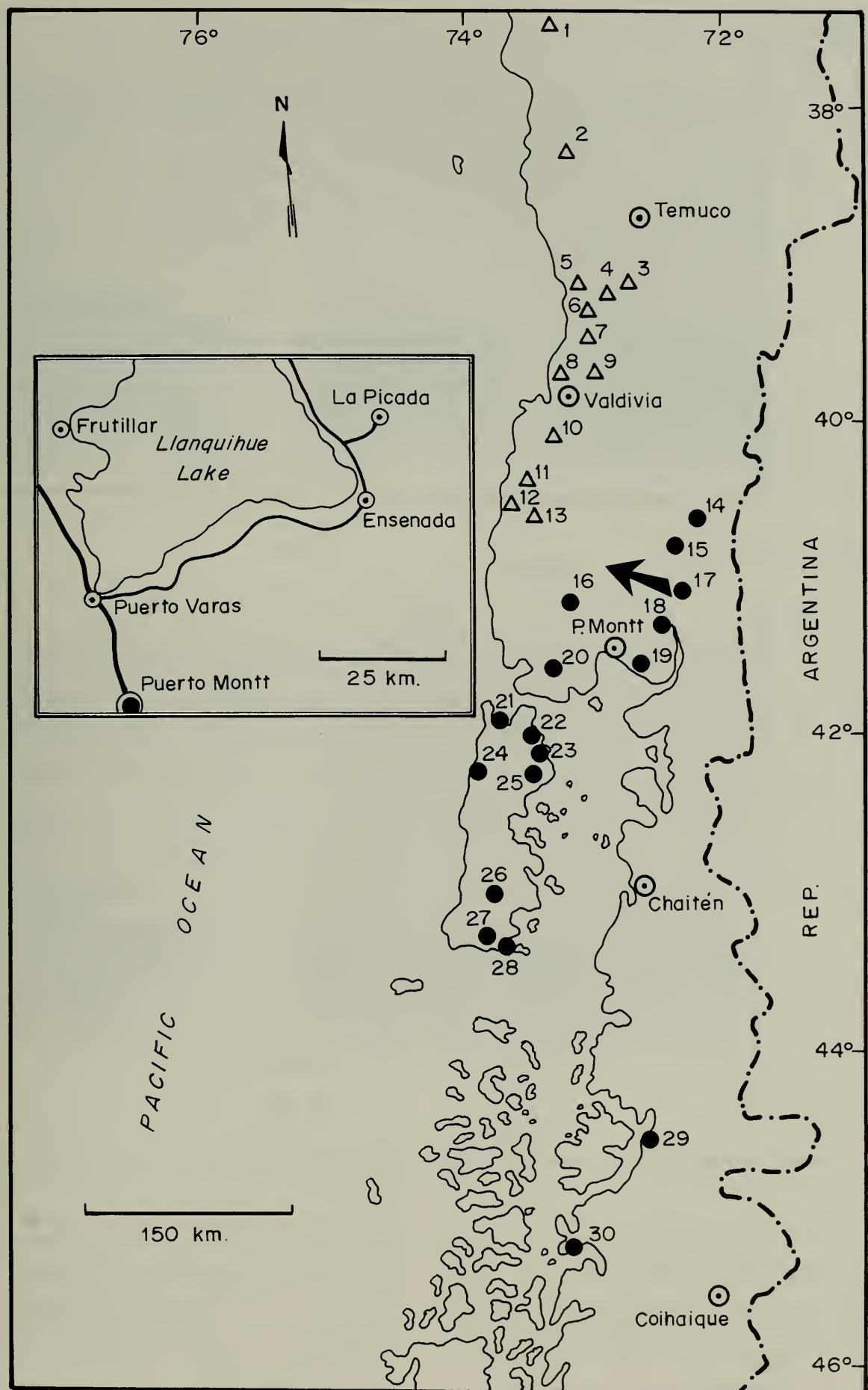
**Habitat.**—La Picada (type locality) (Fig. 2) is a small subandean valley surrounded by forests (*Nothofagus*, *Aextoxicum*, and *Eucryphia*). During winter and summer, frogs were found there under logs, however during the reproductive period (springtime) the animals were collected at the border of a small stream shaded by ferns (*Dryopteris*) and mosses (*Sphagnum* and *Hygroamblystegium*).

From the ecological point of view this area is situated in the oceanic region of mediterranean influence (di Castri 1968). The annual mean temperature of this region is 10.5°C the relative humidity is 84% and the rainfall ranges between 2000 to 2500 mm. Of seventeen examined localities, fifteen are included in the preceding region; however the southernmost localities (Río Cisnes and Caleta Vidal) are situated in the oceanic cold-temperate region (di Castri 1968). The annual mean temperature is 8.8°C, the relative humidity is 87% and the rainfall ranges from 2500 to 3000 mm.

At the type locality the following species of amphibians were also collected: *Rhinoderma darwinii*, *Bufo variegatus*, *Batrachyla leptopus*, *B. antartandica*, *Alsodes monticola*, *Pleurodema thaul*, *Hylorina sylvatica* and *Eupsophus calcaratus*.

**Breeding sites and breeding season.**—Ten breeding sites were examined (Termas de Puyehue, La Picada, El Traiguén, Río Rol-

Fig. 2. Distribution of *Eupsophus emiliopugini* (dots) and *E. vittatus* (triangles) in Southern Chile. Arrow indicates location of the type locality (La Picada) of *E. emiliopugini*. 1) Ramadillas, 2) Contulmo, 3) Mafíl, 4) Linguento, 5) Mehuín, 6) San Martín, 7) Los Molinos, 8) Valdivia, 9) Huellehue, 10) Tres Chiflones, 11) Cordillera Pelada, 12) Bahía Mansa, 13) Pucatrihue, 14) Puyehue, 15) Piedras Negras, 16) El Traiguén, 17) La Picada, 18) Río Rollizo, 19) Río Lenca, 20) Camino Maullín, 21) Ancud, 22) Lechagua, 23) Chepu, 24) Cucao, 25) Puntra, 26) Tepuhueico, 27) Yaldad, 28) Quellón, 29) Río Cisnes, 30) Caleta Vidal.



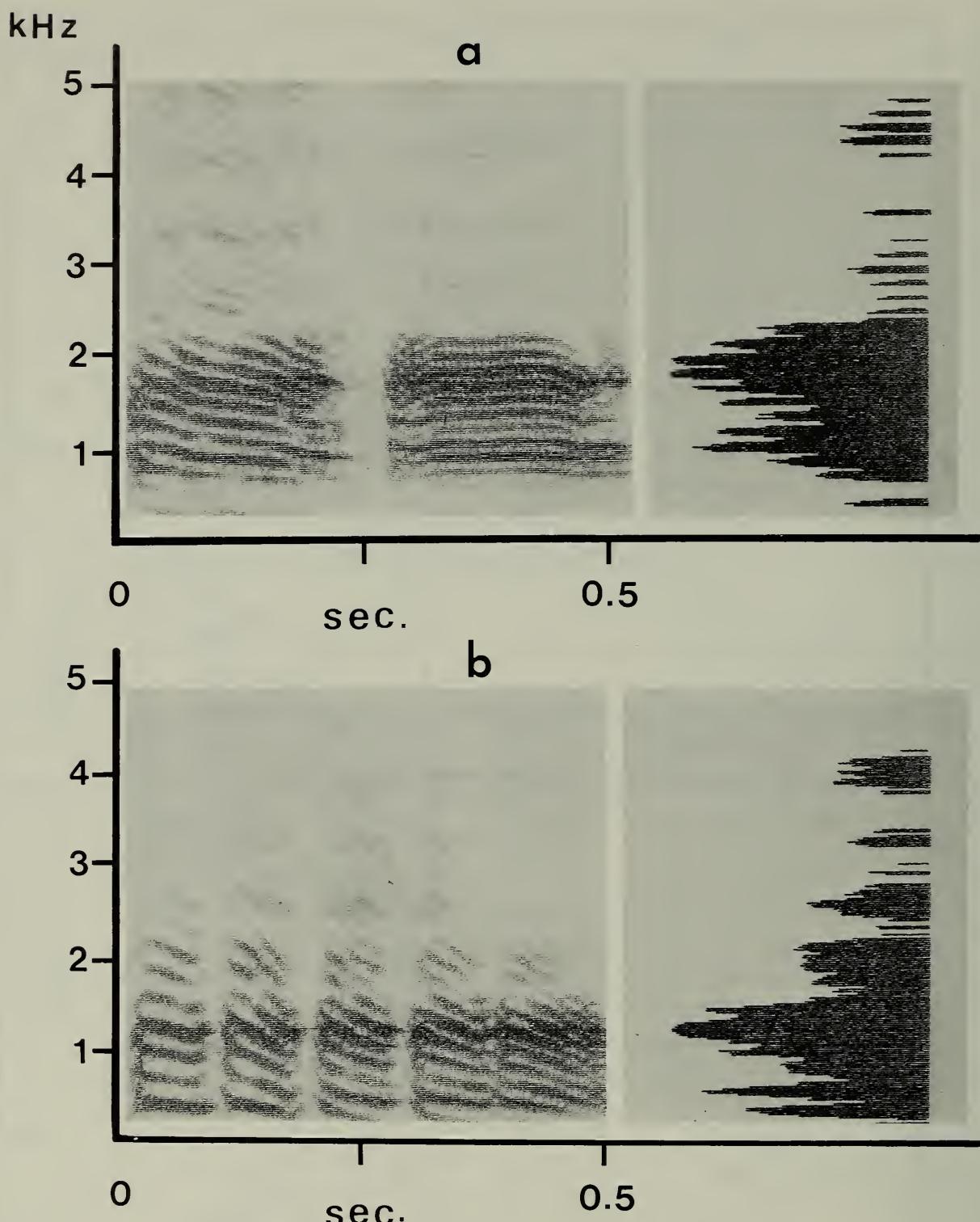


Fig. 3. Audiospectrograms (left) and sections (right) of the mating call of *Eupsophus emiliopugini* (a) and *E. vittatus* (b), band filter 300 Hz.

lizo, Río Lenca, Maullín, Puntra, Cucao, Yaldad, and Caleta Vidal) primarily at La Picada (type locality) and Puntra. Calls have been heard from September to December. Mature females with white oocytes were collected in October (La Picada and Cucao) and tadpoles have been found in December

(Puntra). Males with nuptial asperities were collected from September to December. The breeding sites are series of small water-filled cavities at the border of the streams near the forests.

*Mating call.*—The mating call of *E. emiliopugini* was recorded at seven localities

Table 2.—Characteristics of the mating call of *Eupsophus emiliopugini* and *E. vittatus*. Observed ranges in parenthesis below means; *E. emiliopugini* recorded at Puntra (Chiloé Province) and *E. vittatus* recorded at Mehuín (Valdivia Province). (n = number of analyzed calls.)

Character	<i>E. emiliopugini</i>	<i>E. vittatus</i>
n	10	10
Notes per call	2	5 (4–6)
Notes duration (sec)	0.203 (0.132–0.250)	0.089 (0.062–0.187)
Pulses per note	25.45 (17–34)	15.90 (11–23)
Dominant frequency (Hz)	1132.08 (500–2000)	1154.34 (600–1680)

(Termas de Puyehue, La Picada, El Traigüén, Río Rollizo, Maullín, Puntra, and Yaldad), and 37 frogs were recorded (5°–16°C). The description of the mating call is based on 10 calls from five animals from Puntra. Males of this species were observed and collected while they were calling from cavities in the ground, at the border of a stream. At this locality males were isolated; however, in the other sites a moderate aggregation was observed. The mating call of *E. emiliopugini* is characteristically composed of two notes (Table 2, Fig. 3). Both are similar in duration ( $\bar{x} = 0.20 \pm 0.027$  sec) and have 27 pulses (mean) per note. The fundamental frequency ranges between 85 and 633 Hz and the dominant frequency is spread between 729 and 1320 Hz. Analysis of numerous field recordings demonstrated only minor variations in call characteristics among individuals from different populations. In three localities (La Picada, Río Rollizo, and Puntra) *E. emiliopugini* and *E. calcaratus* were collected calling in close physical association.

**Eggs.**—A female collected at the type locality (La Picada), 24 Sep 1983, had 148 mature oocytes. At the same place (29 Oct 1984 and 21 Nov 1985) two clutches,

Table 3.—Measurements (mm) ( $\bar{x} \pm SD$ ) of 30 tadpoles of *Eupsophus emiliopugini* at developmental stage 37 (Gosner 1960).

Total length	$23.2 \pm 0.74$
Body length	$9.6 \pm 0.24$
Body deep	$5.0 \pm 0.21$
Fin deep	$6.5 \pm 0.36$
Snout-nostril distance	$1.2 \pm 0.002$
Interocular distance	1.7
Eye diameter	$1.0 \pm 0.009$
Mouth width	$2.5 \pm 0.12$

containing 166 and 131 eggs (5.78–6.9 mm diameter) respectively, were found in water-filled cavities covered by mosses (*Sphagnum*). Eggs were stuck to one another and were creamy-white in color.

**Tadpole.**—131 larvae of *E. emiliopugini* were collected in a water-filled cavity near (20 cm) a cold stream (12°C) at Puntra (6 Dec 1984). The measurements of the tadpoles are indicated in Table 3. Gosner's (1960) developmental stages are used in the following description. Larvae in stage 37 (Fig. 4a, b) with body ovoid in lateral view, two times longer than deep; contour of the snout flattish. Nostrils small, situated between eye and snout tip. Eyes lateral, diameter 1.7 times the interocular distance. Mouth small and anteromedial, labial papillae interrupted anteriorly, few denticles and tooth formula 2/2; beak well developed. Anal tube medial; no spiracle but small ventrolateral fissure on the left side of the body. Caudal musculature robust, dorsal and ventral fins well developed; end of tail rounded. Color in life creamy-white abdomen and fins transparent; internal organs visible. Minute melanophores among the nearest muscular septa to the body. Dorsal areas of head and trunk scarcely pigmented. On completion of metamorphosis (10 Mar 1985) frogs were 10.1–10.6 mm in snout–vent length. Froglets have the dorsum gray with two well developed paravertebral folds also found in the adults.

**Juvenile.**—Juveniles (five fixed specimens from La Picada) exhibit the same

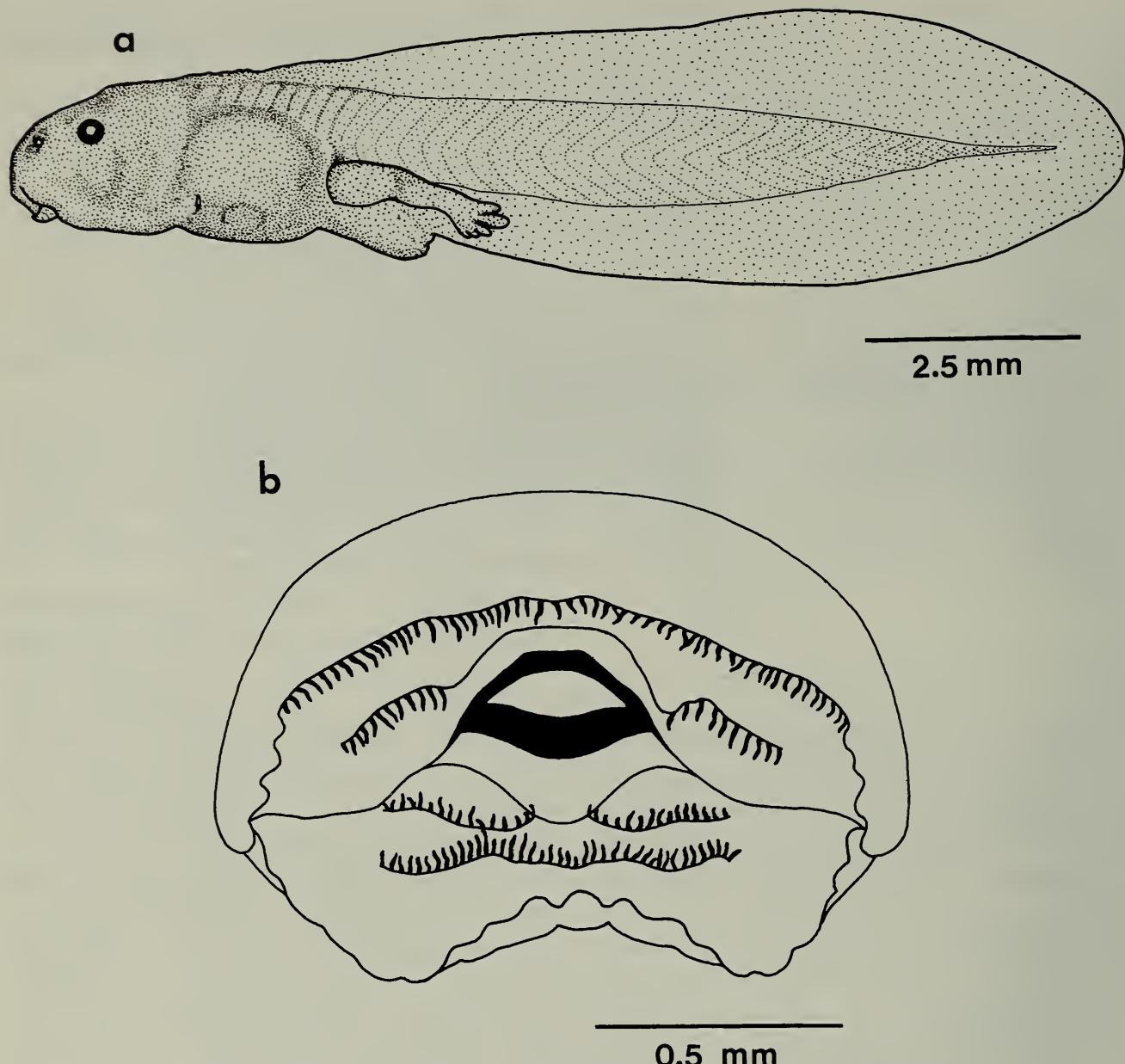


Fig. 4. Tadpole of *Eupsophus emiliopugini*, lateral view (a) and mouth (b). Gosner stage 37.

characteristics of the adults; however, some differences were observed. The two paravertebral folds are well developed and the dorsum and flanks are covered by minute granules. The gular area is dark gray and the olive-green interocular band is not evident.

**Variation.**—Measurements of 54 adults (40 males and 14 females) (Table 1) show sexual size dimorphism. Of the 99 specimens examined (54 adults and 45 juveniles), 59 specimens (60.2%) have a mid-dorsal line, 38 specimens lack a mid-dorsal line (37.7%) and two specimens (2.1%) from Punta (IZUA 2060, 2062) exhibit scattered

whitish irregular spots on a dark background.

**Etymology.**—The trivial name honors the memory of my friend and colleague Prof. Dr. Emilio Pugín, for his contribution to knowledge of the reproductive biology and development of the Chilean frogs.

#### Comparisons

When the adult snout-vent length of *E. emiliopugini* (males  $\bar{x} = 46.7$  mm; females  $\bar{x} = 50.6$  mm) is compared with that of other *Eupsophus* species, it is observed that this

frog is as large as *E. vittatus* (males  $\bar{x} = 54.4$  mm; females  $\bar{x} = 59.6$  mm) (Table 1). Both taxa differ from their smaller congeners *E. roseus* (36.6 mm in snout-vent length), *E. migueli* (35.5 mm), *E. calcaratus* (35.1 mm), and *E. insularis* (39.9 mm) (Formas and Vera 1982).

In habitus and dorsal pattern, *E. emiliopugini* is similar to *Eupsophus vittatus*; however, both species differ in external features. *Eupsophus emiliopugini* has an olive-green band between the eyes, which is absent in *E. vittatus*. Furthermore, the latter has the vertebral line wide and creamy-white in color while in *E. emiliopugini* it is narrow and lemon-yellow colored.

Remarkable differences are found between the mating calls of *E. emiliopugini* and *E. roseus*, *E. migueli*, and *E. calcaratus*. The mating call of *E. emiliopugini* has two notes while the other species presents only one note (Formas 1985). Differences between the voices of *E. emiliopugini* and *E. vittatus* are presented in Table 2 and Fig. 3.

From the geographical point of view *E. emiliopugini* and *E. vittatus* demonstrate a different range of distribution (Fig. 2). Both taxa are allopatric, and *E. vittatus* is distributed in the Coastal Range and the Central Valley between Ramadillas ( $37^{\circ}18'S$ ;  $73^{\circ}14'W$ ) and Bahía Mansa ( $40^{\circ}33'S$ ;  $73^{\circ}46'W$ ).

### Specimens Examined

**Abbreviations.**—Instituto de Zoología, Universidad Austral de Chile (IZUA); Field Museum of Natural History (FMNH); Museo de Zoología, Universidad de Concepción (MZUC); Juan Carlos Ortíz (personal collection) (J.C.O.); Nelson Díaz (personal collection) (N.D.).

*Eupsophus emiliopugini*. (99) Osorno: Puyehue ( $40^{\circ}42'S$ ;  $72^{\circ}18'W$ ), IZUA 1931, 1933–34, 2012 (tape); Piedras Negras ( $40^{\circ}53'S$ ;  $72^{\circ}27'W$ ), IZUA 1951–53; La Picada ( $41^{\circ}04'S$ ;  $72^{\circ}26'W$ ), FMNH 218584–85, IZUA 1585–88, 1950, 1953, 1608,

1955–75, 2101 (tape). Llanquihue: Río Lenca ( $41^{\circ}37'S$ ;  $72^{\circ}40'W$ ), IZUA 1939, 1948–50, 1939–45; El Traiguén ( $41^{\circ}11'S$ ;  $73^{\circ}25'W$ ), IZUA 2103 (tape); Río Rollizo ( $41^{\circ}27'S$ ;  $72^{\circ}20'W$ ), IZUA 2104 (tape); Road to Maullín ( $41^{\circ}41'S$ ;  $73^{\circ}21'W$ ), IZUA 2102 (tape). Chiloé: Ancud ( $41^{\circ}52'S$ ;  $73^{\circ}50'W$ ), J.C.O. 61/1–61/3, 68/13, 33/3; Lechagua ( $41^{\circ}53'S$ ;  $73^{\circ}51'W$ ), FMNH 154829–30; Chepu ( $42^{\circ}03'S$ ;  $74^{\circ}02'W$ ), MZUC 11939; Puntra ( $42^{\circ}07'S$ ;  $73^{\circ}49'W$ ), IZUA 2059–64, 2104 (tape); Tepuhueico ( $42^{\circ}47'S$ ;  $73^{\circ}58'W$ ), (2 adults and 6 juveniles untagged); Cucao ( $42^{\circ}37'S$ ;  $74^{\circ}07'W$ ), IZUA 1627–28; Quellón ( $43^{\circ}07'S$ ;  $73^{\circ}37'W$ ), FMNH 3715; Yaldad ( $43^{\circ}07'S$ ;  $73^{\circ}43'W$ ) 2078–95, 2105 (tape). Aisén: Puerto Cisnes ( $43^{\circ}30'S$ ;  $71^{\circ}19'W$ ), FMNH 132050–52, 132317, 132659; Caleta Vidal ( $45^{\circ}16'S$ ;  $73^{\circ}27'W$ ), (1 adult untagged).

*Eupsophus vittatus*. (103) Arauco: Ramadillas ( $37^{\circ}18'S$ ;  $73^{\circ}16'W$ ), MZUC 11482; Contulmo ( $38^{\circ}S$ ;  $73^{\circ}13'W$ ), IZUA 272/80. Valdivia: Mehuín ( $39^{\circ}26'S$ ;  $73^{\circ}10'W$ ), IZUA 832–36, 1644–46, N.D. 1–6, IZUA 2096; San Martín ( $39^{\circ}33'S$ ;  $72^{\circ}59'W$ ), IZUA 1716–20, 1724, 2097 (tape), 2028–52; Linguento ( $39^{\circ}33'S$ ;  $72^{\circ}59'W$ ), IZUA 1937–38, 2098 (tape); Máfil ( $39^{\circ}39'S$ ;  $72^{\circ}57'W$ ), FMNH 3825–27; Ciudad de Valdivia ( $39^{\circ}48'S$ ;  $73^{\circ}14'W$ ), IZUA 225–28; Huellehue ( $39^{\circ}44'S$ ;  $73^{\circ}06'W$ ), IZUA 1929–30, 2099 (tape); Los Molinos ( $39^{\circ}46'S$ ;  $73^{\circ}18'W$ ), IZUA 1936; Tres Chiflones ( $40^{\circ}03'S$ ;  $73^{\circ}10'W$ ), IZUA 2009–27; Cordillera Pedada ( $40^{\circ}03'S$ ;  $73^{\circ}10'W$ ), IZUA 1935. Osorno: Pucatrihue ( $40^{\circ}26'S$ ;  $73^{\circ}47'W$ ), MZUC 12402, IZUA 1988–2008, 2100 (tape); Bahía Mansa ( $40^{\circ}33'S$ ;  $73^{\circ}46'W$ ), J.C.O. 69/74.

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